First Ideas and Design Implementation for a Low Q^2 Tagger

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Outline

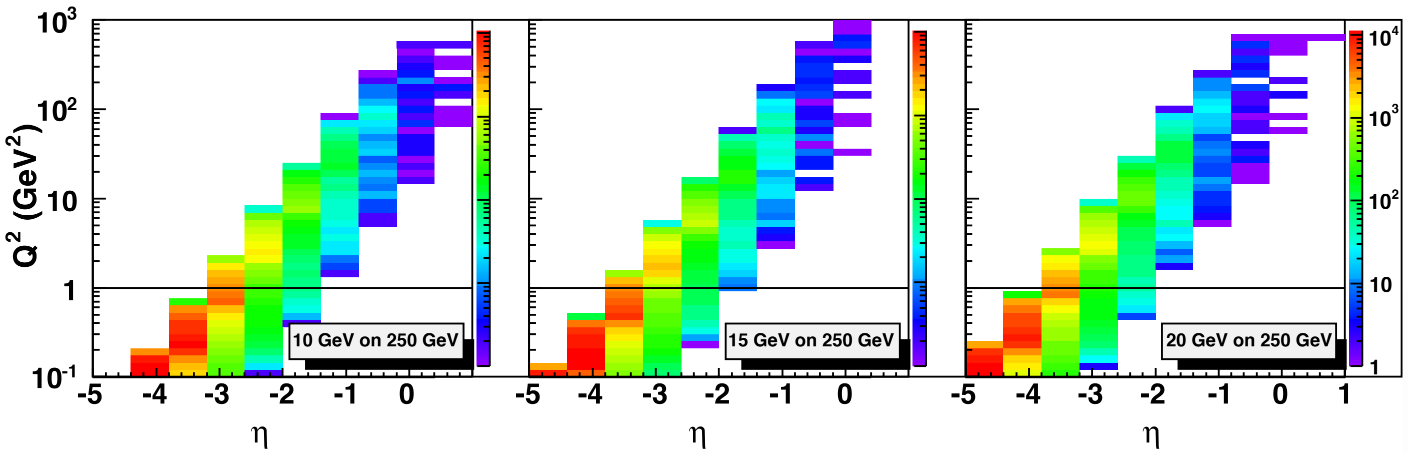
- Motivation for a low Q^2 tagger
- Basics of the simulation setup and initial design
- Event displays
- Improvements in the works

Motivation for a low Q^2 Tagger

- Low Q^2 events dominate the cross-section of ep interactions
- Study quasi-real photoproduction physics
- generally the beam electron will scatter at small angles
  - will scatter outside the acceptance of the main detector
  - need detector at large pseudo-rapidity to catch these events and be able to calculate Q^2
    - calculate Q^2 via scattered electron
    - $Q^2 = 2E_eE_e'(1 - \cos\Theta_e)$

LOW Q^2-TAGGER

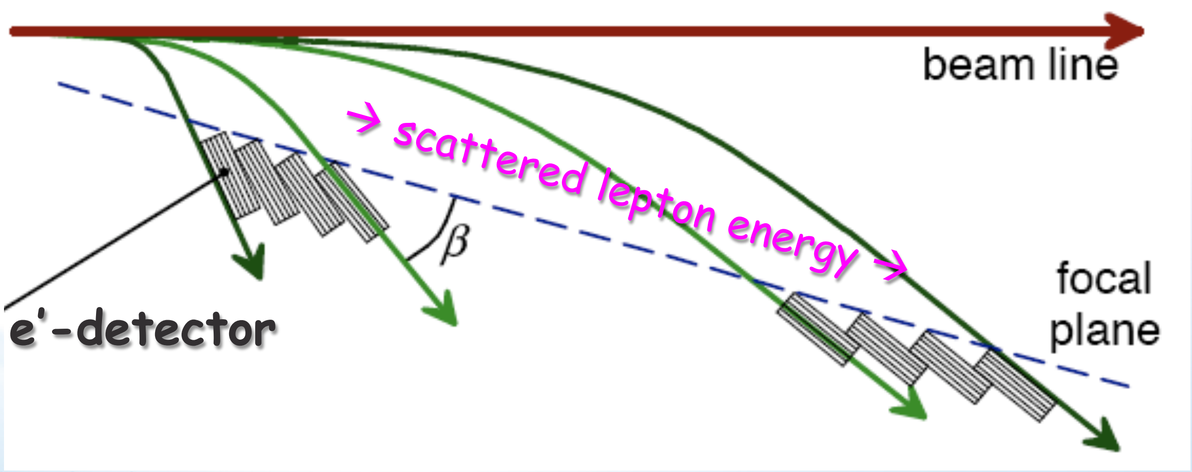
- Task: detect low Q^2 scattered electrons
  → quasi-real photoproduction physics



DIS electron kinematics

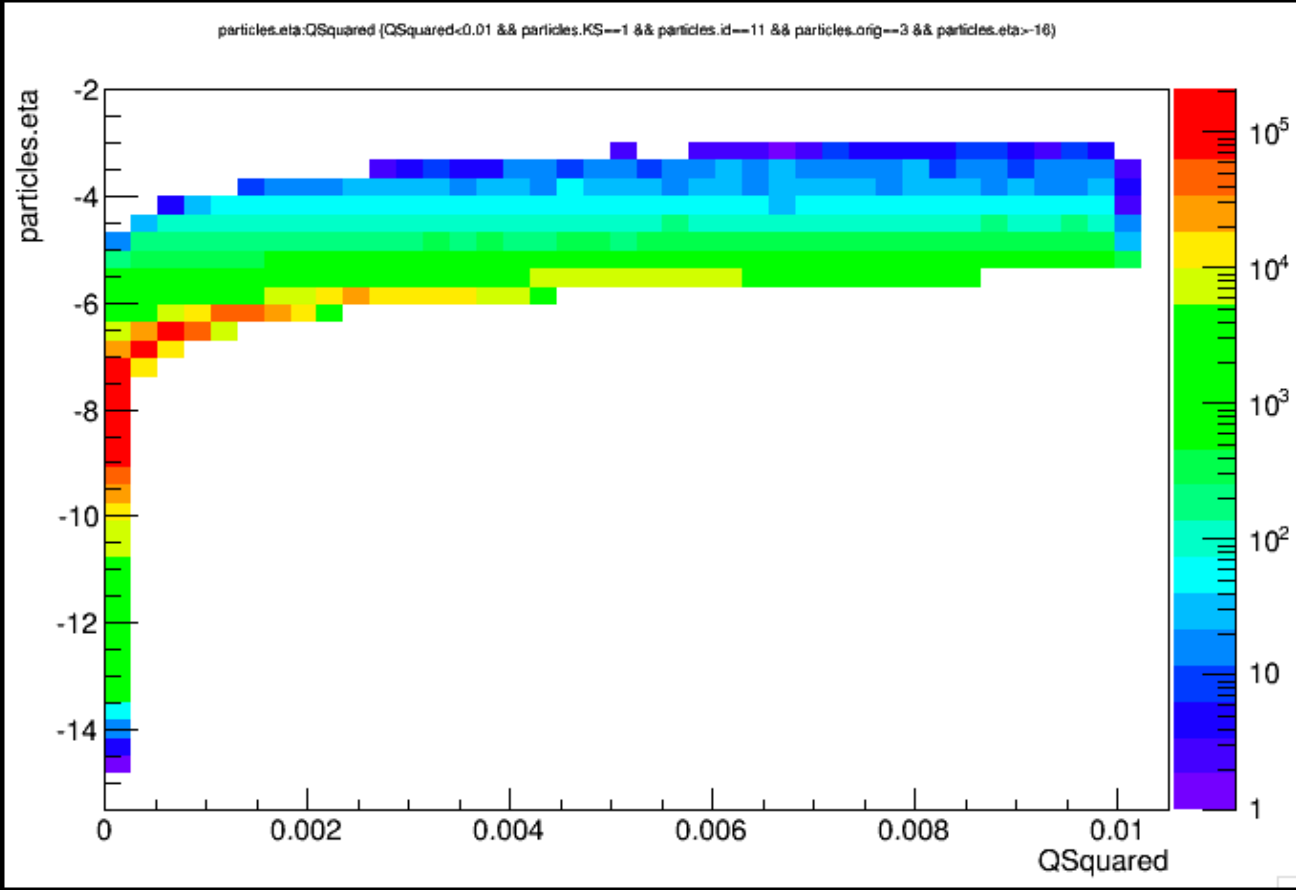
-> at nominal energy can not register scattered electrons with Q^2<0.1 in main spectrometer!

- need a separate device designed similar to the JLab Hall D tagger (finely spaced scintillator array):



Pythia Simulation Characterizing Low Q^2 Events

- Take a quick look at existing pythia TTrees on disk
  - /eicdata/eic0004/PYTHIA/ep/NEWTREES/10x250.5Mevents.1.RadCor=0.root (now disappeared actually)
- plot eta vs Q^2 of the scattered electron below



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- Take a quick look at existing pythia TTrees on disk
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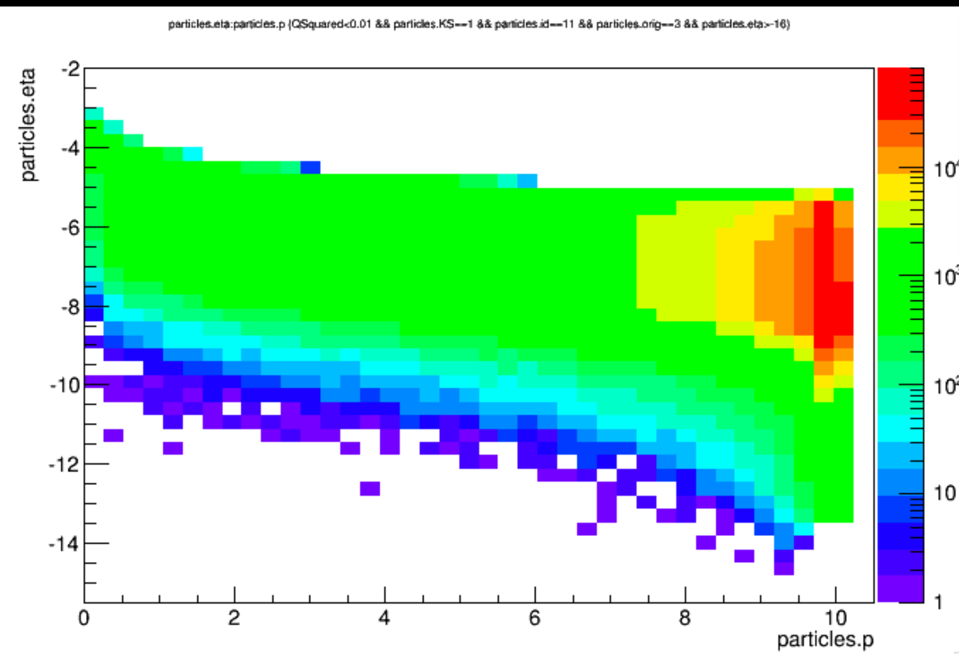
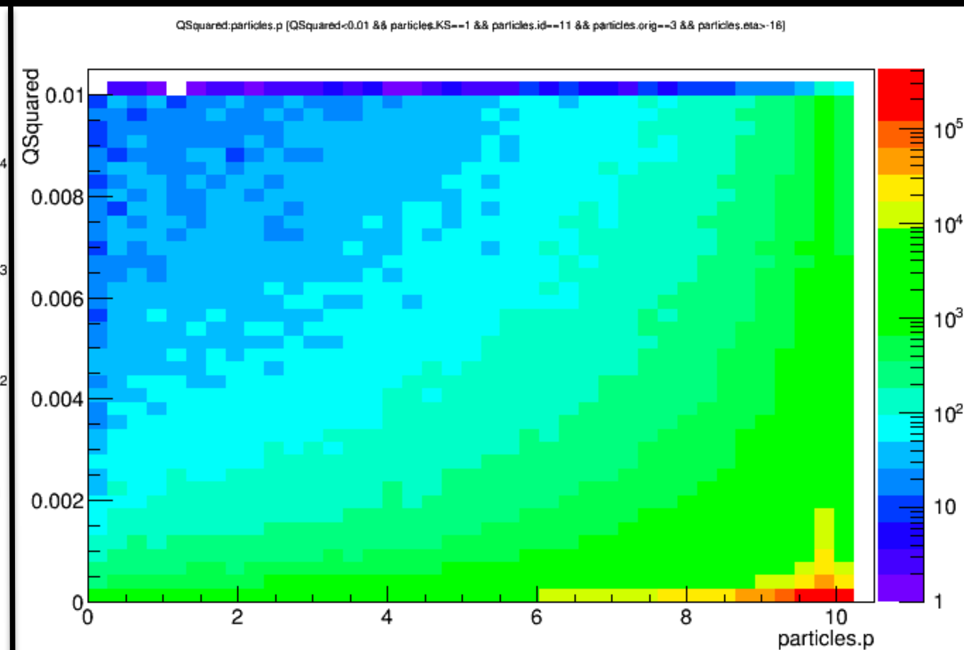
- plot momentum of the scattered electron below



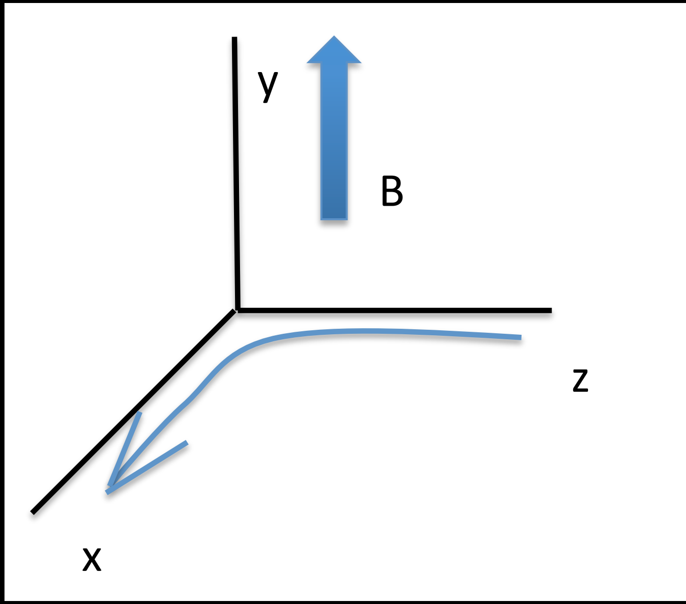


Very Early Design

- choice in design for the moment is more or less arbitrary
  - have not yet given careful consideration to detector technology, size constraints, etc.
  - mostly an exercise is getting the code up and running and to generate initial ideas to move forward
- Utilizing the EICroot framework developed by Alexander
  - in the process of setting up a wiki page with more info
  - https://wiki.bnl.gov/eic/index.php/Eicroot
- Currently detector is implemented in a single script that utilizes existing classes
  - plan to create a LQS tagger class to keep in form with standards already set in place by Alexander
- Local copy base directory
  - /direct/eic+u/rmpetti/workarea/eicroot/
- Simulation chain code is in
  - tutorials/designer/lowq2tagging
  - Includes scripts lowq2tagger.C, dipoleField.dat, simulation.C, eventDisplay.C
    - lowq2tagger.C implements the detector setup
    - dipoleField.dat is an ascii file defining a dipole field
    - simulation.C runs the particle generation and propagation through field and detector
    - eventDisplay.C runs the event display

lowq2tagger.C

- very early design
- utilizing existing material defined in geometry/media.geo
  - PbSciMix
- each cell face is 25mm x 25mm and 200mm long
- array of 20 towers (4 m long device)
- each tower element is rotated about the y-axis
- angle of rotation is dependent of distance from the interaction point
  - determined from the field strength



$$\alpha[rad] = 299.8\frac{\int B[T]\cdot ds[m]}{p[MeV/c]}$$

dipoleField.dat

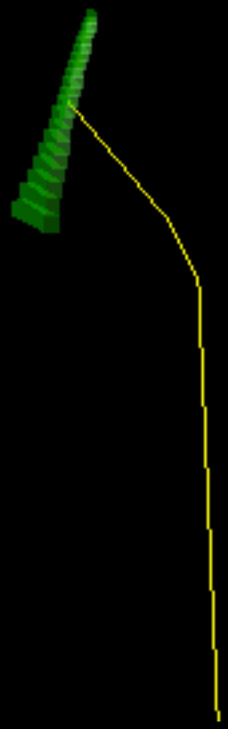
- ASCII file encodes simple dipole field
- defined in a box 2x2x0.5 m in xyz space
- field only has an y component of 10T in strength
- field defined from
  - -1 < x < 1 m
  - -1 < y < 1 m
  - 4.5 < z < 5 m
- run macro/field/f2root.C to convert ascii file to root binary to feed into simulation.C
  - adapted (in my private version) to take field option of "Solenoid" or "Dipole" as input
- Need to get more realistic design parameters from the machine group

simulation.C

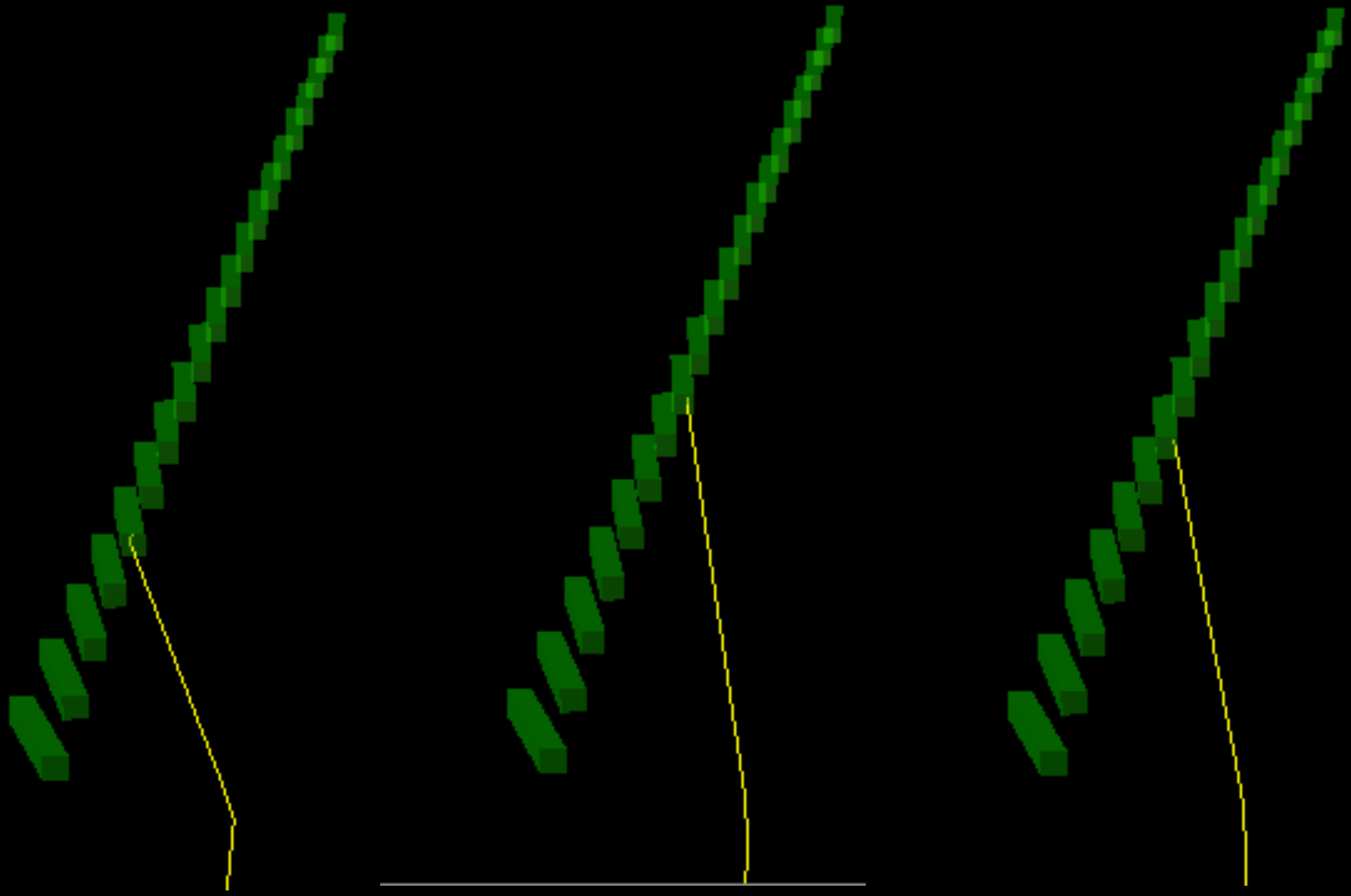
- mostly using default setup for now
- simulation.C needs
  - output of lowq2tagger.C
    - binary root file encoding detector geometry
  - output of f2root.C
    - binary root file encoding field configuration
- generates (single) electrons
- will show events with $5 < p < 20$ GeV/c
- generation in full azimuth

Event Display

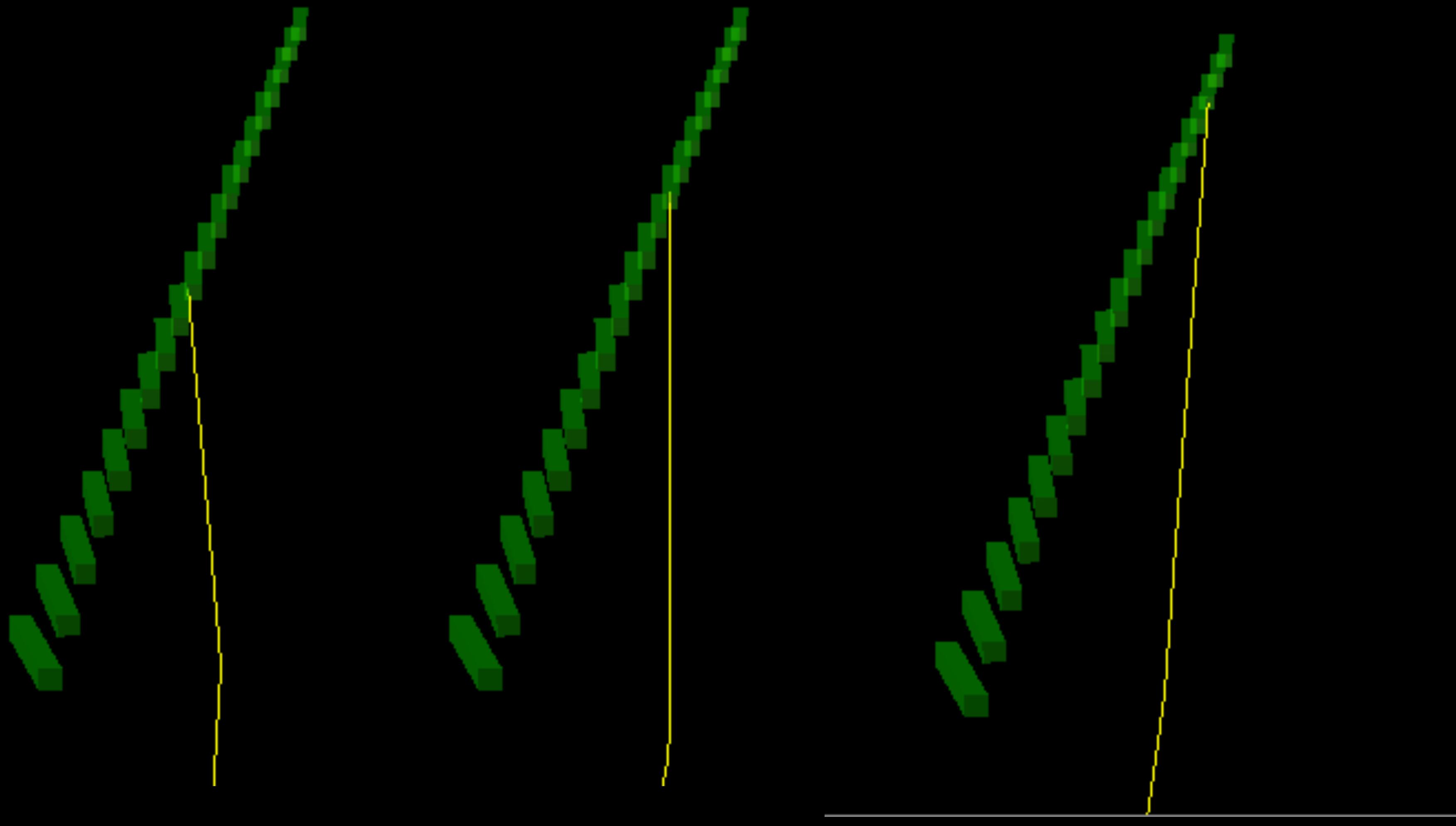
- generated with $\theta = 0^o$
- first a zoom out to orient you with the beam trajectory and bend plane



Event Display

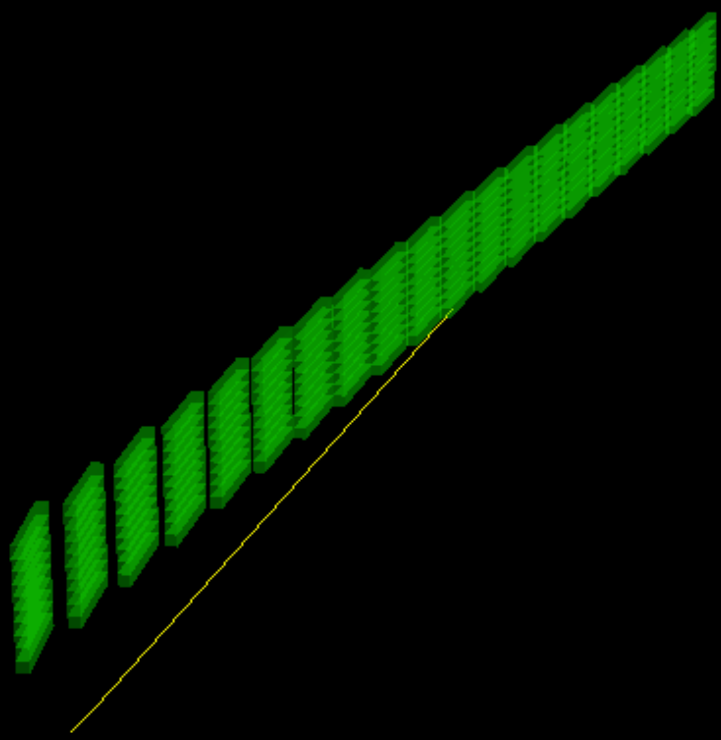


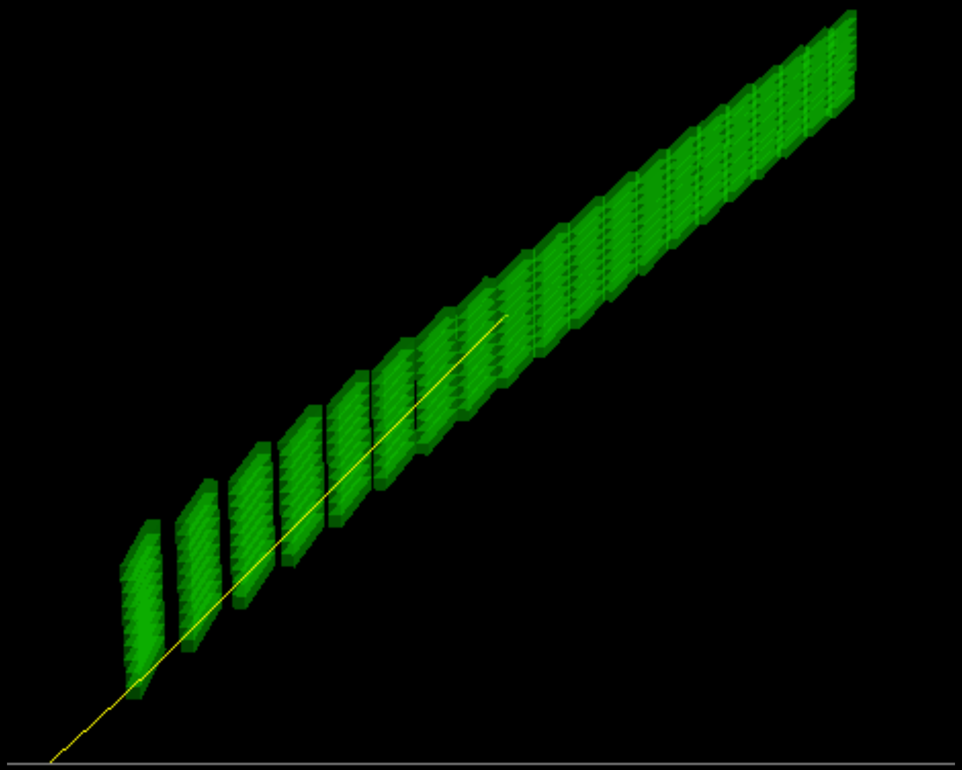
Event Display



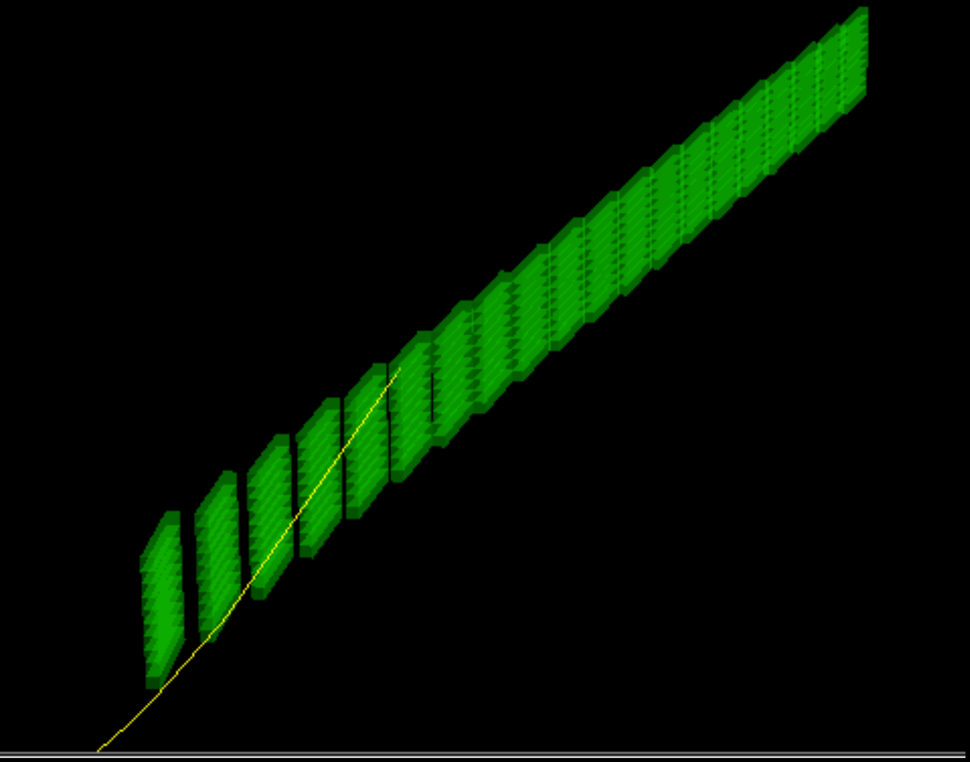
Event Display

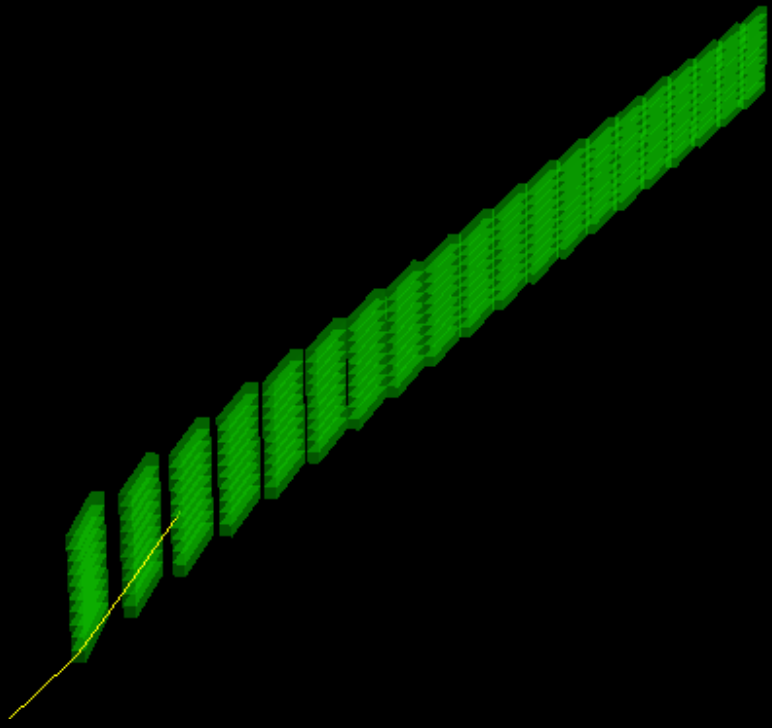
- generate with $\theta = 1^o$
- stack previous arrays in the y-direction (right now 20x10 array)
- still need to tilt towers in this direction to keep particle normal with tower face





Event Display





Upcoming Improvements

- In general, improve reality of the simulation
  - Get more realistic field parameters
  - Choose a suitable technology
  - Better determine size of towers
  - Improve placement of towers to eliminate gaps
  - Extend design to capture electrons scattered at a non-zero θ angle
- Determine better the constraints from physics
  - what energies are we interested in capturing?
  - what is the required Q^2 resolution (and thus the energy and position resolution)?
- Implement mapping functions for eventual reconstruction